
ORIGINAL ARTICLE

The modified Misgav-Ladach versus the Pfannenstiel–Kerr technique for cesarean section: a randomized trial

PEDRO XAVIER¹, DIOGO AYRES-DE-CAMPOS¹, ANA REYNOLDS¹, MARIANA GUIMARÃES¹, CRISTINA COSTA-SANTOS² AND BELMIRO PATRÍCIO¹

From the ¹Departamento de Ginecologia e Obstetrícia, and ²Departamento de Bioestatística e Informática Médica, Faculdade de Medicina da Universidade do Porto/Hospital de São João, Porto, Portugal

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Background. Modifications to the classic cesarean section technique described by Pfannenstiel and Kerr have been proposed in the last few years. The objective of this trial was to compare intraoperative and short-term postoperative outcomes between the Pfannenstiel–Kerr and the modified Misgav-Ladach (MML) techniques for cesarean section.

Methods. This prospective randomized trial involved 162 patients undergoing transverse lower uterine segment cesarean section. Patients were allocated to one of the two arms: 88 to the MML technique and 74 to the Pfannenstiel–Kerr technique. Main outcome measures were defined as the duration of surgery, analgesic requirements, and bowel restitution by the second postoperative day. Additional outcomes evaluated were febrile morbidity, postoperative antibiotic use, postpartum endometritis, and wound complications. Student's *t*, Mann–Whitney, and Chi-square tests were used for statistical analysis of the results, and a *p* < 0.05 was considered as the probability level reflecting significant differences.

Results. No differences between groups were noted in the incidence of analgesic requirements, bowel restitution by the second postoperative day, febrile morbidity, antibiotic requirements, endometritis, or wound complications. The MML technique took on average 12 min less to complete (*p* = 0.001).

Conclusion. The MML technique is faster to perform and similar in terms of febrile morbidity, time to bowel restitution, or need for postoperative medications. It is likely to be more cost-effective.

Key words: modified Misgav-Ladach technique; randomized clinical trial

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Cesarean delivery remains the most common intraperitoneal surgical procedure in obstetrical and gynecologic practice (1). François Mauriceau first reported its use in the seventeenth century, but perhaps the most significant technical evolution occurred in the late nineteenth century when uterine wall suturing led to a marked reduction in the mortality associated

with the procedure (2). In 1897, Pfannenstiel (3) proposed the use of a curved transverse supra-pubic incision in the abdominal skin, and in 1926 Kerr (4) introduced the transverse lower uterine segment incision, including in his description double-layer uterine suture and peritoneal closure. These techniques gained wide acceptance in obstetric practice during the second half of the twentieth century, although many small variations were probably employed by different clinicians.

Abbreviations:

MML: modified Misgav-Ladach; PK: Pfannenstiel and Kerr.

In 1972, a new method for opening the abdominal wall was reported by Joel-Cohen and colleagues (5), involving a transverse skin incision 5 cm above the symphysis and blunt dissection of the abdominal wall. During the late 1980s and 1990s, one-layer suturing the uterus (6–10) and non-closure of the peritoneum (11–17) were also advocated. The first evaluation of these three modifications performed in conjunction was described by Stark and colleagues (18–20) in 1995, using a technique that took the name of the hospital that most contributed to its development, the Misgav Ladach.

While the simplicity and the advantages of the Misgav-Ladach technique have been well demonstrated (19,20), the adoption of the Joel-Cohen incision limited its implementation among us, mainly because patients disfavored its aesthetic result. This aspect, together with emerging evidence in favor of alternative individual steps for the procedure, led us to propose modifications to the original Misgav-Ladach technique (21), which we believe has made it more acceptable to both clinicians and patients.

The objective of this study was to compare intraoperative and short-term postoperative outcomes between the modified Misgav-Ladach (MML) and the classic cesarean section technique described by Pfannenstiel and Kerr (PK).

Materials and methods

Patients were considered eligible if scheduled for elective or emergency cesarean section by one of three experienced surgeons. It was considered necessary for each of these surgeons to perform at least 50 first-time and 10 repeat cesareans using both techniques, before entering the study. Patients with a previous midline infraumbilical skin incision, axillary temperature exceeding 37.5°C in the 48 hr before surgery, or antibiotic use in the preceding week were excluded prior to randomization. After informed consent was obtained, patients were allocated to one of the two study arms according to a sequence of computer-generated random numbers. Pre-allocation concealment was assured by an individual strip of black tape removed from the computer-generated list at the time of randomization. The study was approved by the hospital ethics committee.

Description of the modified Misgav-Ladach technique (MML)

After a Pfannenstiel skin incision, the subcutaneous tissue is opened upward in the midline, so as to reach the rectus sheath above the insertion of the pyramidalis muscles. Lateral extension of the subcutaneous tissue, rectus sheath incision, and separation of the two rectus muscles are performed digitally. If the rectus sheath was opened below the insertion of the pyramidalis muscles, a single cut with the scissors is performed in the midline so as to allow the separation of these two structures. Opening of the parietal peritoneum at the upper level of the intermuscular space is performed digitally. A transverse 2–3-cm lower uterine segment incision

in the midline, using a scalpel and involving both peritoneum and myometrium is accomplished with subsequent dissection of the remaining uterine fibers and opening of the fetal membranes using a Kelly's clamp. After lateral digital extension of the uterine incision, the fetus is extracted and the placenta is removed by transabdominal uterine massage combined with light cord traction. The uterine fundus can optionally be removed from the abdominal cavity if this is thought to aid suturing. Closure of the uterine incision is accomplished with a one-layer continuous #1 polyglactin 910 (Vicryl®, Ethicon, Inc., Somerville, Massachusetts, USA) suture, using additional hemostatic stitches if required. After the inspection of the peritoneal cavity and removal of accessible blood and clots, the visceral and parietal peritoneum is left unsutured. The rectus muscles, subfascial space, and subcutaneous tissue are inspected for hemostasis, and the rectus sheath is closed using a continuous #1 polyglactin 910 suture. The subcutaneous tissue is sutured if its depth exceeds 2 cm. The skin is closed with mattress stitches, continuous subcuticular suture, or clips, according to the surgeon's choice.

Description of the Pfannenstiel–Kerr technique (PK)

The skin is opened with a Pfannenstiel incision, extended through the subcutaneous tissue with a scalpel until the rectus sheath is exposed and the latter is then opened in the midline. Scissors are used to extend the rectus sheath incision laterally and to separate it from the pyramidalis and rectus muscles. After the digital separation of the two rectus muscles, the parietal peritoneum is opened with scissors after being elevated between two Kelly's clamps. A transverse low uterine segment peritoneal incision is performed with a scalpel in the midline and then extended laterally with scissors. The peritoneum is dissected downward with scissors to create a bladder flap. The myometrium is incised in the midline with a scalpel, and the remaining uterine fibers and fetal membranes are opened with a Kelly's clamp. After lateral extension of the uterine incision with uterine scissors, fetal extraction and removal of the placenta using transabdominal uterine massage combined with light cord traction is performed. Closure of the uterine incision is accomplished with a two-layer continuous #1 polyglactin 910 suture, using additional hemostatic stitches if required. The visceral peritoneum is closed with a continuous #2/0 polyglactin 910 suture. After the inspection of the peritoneal cavity and aspiration of all accessible blood and clots, the parietal peritoneum is closed in a similar fashion. The rectus muscles, subfascial space, and subcutaneous tissue are checked for hemostasis, and the rectus sheath is closed with a continuous #1 polyglactin 910 suture. The subcutaneous tissue is sutured if its depth exceeds 2 cm. The skin is closed with separate mattress stitches, continuous subcuticular suture, or clips, according to the surgeon's choice.

A total of 162 women were included for randomization in this study, 88 allocated to the MML technique and 74 to the PK technique. Sixteen women (9.9%) were excluded after randomization, 12 because it was not possible to contact them after discharge from hospital and the remaining four because they left the hospital before the third postoperative day (11 in the MML group and five in the PK group).

Main outcome measures were defined as the duration of surgery, analgesic requirements, and bowel restitution by the second postoperative day. Additional outcomes evaluated were febrile morbidity, postoperative antibiotic use, postpartum endometritis, and wound complications.

The planned study of 160 patients had an 80% power to detect a difference between the two techniques of 20% in bowel restitution by the second postoperative day (assuming

70% and 50% for MML and PK, respectively), at the 5% significance level.

The type of anesthesia employed was decided by the anesthesiologist on call, without knowledge of the study arm that patients were allocated to. Prophylactic antibiotics were administered to all women after umbilical cord clamping: 2 g of intravenous (i.v.) ampicillin or 500 mg of i.v. erythromycin in patients with hypersensitivity to penicillins. Postoperative analgesics were administered routinely as follows: when general anesthesia or spinal block was employed, 100-mg tramadol tid intravenously was administered during the first 24 hr. In women receiving epidural anesthesia, 2.5-mg morphine bid was administered through the epidural catheter, for the first 24 hr. After the first 24 hr, until the first 48 hr, all patients received 1 g of oral paracetamol tid and, on request, 50 mg of intramuscular meperidine (maximum of 150 mg per day). After the second postoperative day, all patients received, on request, 1 g of oral paracetamol (maximum of 4 g per day) and/or 50 mg of intramuscular meperidine (maximum of 150 mg per day). Sodium citrate of 90 mg rectal bid or 5 ml of oral lactulose tid were started on the second postoperative day if no bowel movements had occurred by then.

Duration of surgery was measured with a chronometer by the anesthetist present in the operating theater and was defined as the time elapsed between skin incision and skin closure. Analgesic requirements, antibiotic use, and day of bowel restitution were obtained from the hospital notes and confirmed with patients on the fourth postoperative day. Febrile morbidity was defined as an axillary temperature in excess of 38 °C, lasting for at least 48 hr. Postpartum endometritis was recorded when purulent vaginal discharge, accompanied by uterine tenderness and/or an axillary temperature exceeding 38 °C, occurred. Wound complications were evaluated on the fourth and fifteenth postoperative day. They were classified as mild if serous drainage, erythema, and/or induration of the skin incision were found. Purulent drainage, hematoma, and/or dehiscence were considered severe wound complications. Length of hospitalization was not considered an important parameter in this study, as it is routine policy in our Department to discharge uncomplicated cesarean section patients on the fourth postoperative day. The staff in charge of the postoperative period was unaware of the surgical technique employed in individual patients.

For continuous variables with normal distribution, differences were evaluated using Student's *t*-test, while the

Mann–Whitney test was employed for variables with non-normal distribution. The Chi-square test was used for categorical variables. Statistical analysis was performed using SPSS for Windows® (version 10.0.7) with a two-sided 5% significance level.

Results

The main obstetrical characteristics of the study population are listed in Table I. The primary indication for cesarean delivery in these patients is presented in Table II. No significant differences occurred between the two arms, regarding any of these parameters.

The outcome measures evaluated are listed in Table III. There were no cases of postpartum endometritis or intraoperative complications in either arm, but a serious postoperative hemorrhage occurred in a patient on high doses of low molecular weight heparin in the MML group requiring blood transfusions and hysterectomy. The MML technique took significantly less time to perform. Although there were no significant differences between both groups in the incidence of analgesic requirements, bowel restitution by the second postoperative day, febrile morbidity, antibiotic requirements, or wound complications, a trend toward decreased febrile morbidity, and an increased bowel restitution by the second postoperative day were noted in the MML group.

Discussion

Many of the recent modifications to the cesarean section technique described by Pfannenstiel and Kerr have been evaluated both individually and in combination. One-layer suturing the uterus is reported to result in less operative time, better hemostasis, and less infectious morbidity than

Table I. Main obstetrical characteristics of the study population

	MML (<i>n</i> = 77)	PK (<i>n</i> = 69)	<i>p</i> -value
Maternal age (years)	28 (19–42)	28 (18–41)	NS
Maternal weight (kg)	74 (55–101)	76 (53–110)	NS
Gestational age median (weeks)	38 (27–42)	38 (29–42)	NS
Parity			NS
One	47 (61%)	39 (57%)	
Two	19 (25%)	21 (30%)	
Previous cesareans sections			NS
No (%)	68 (88%)	57 (83%)	
Yes (%)	9 (12%)	12 (17%)	
Anesthesia employed for cesarean section			NS
General (%)	52 (67%)	49 (71%)	
Spinal (%)	2 (3%)	1 (1%)	
Epidural (%)	23 (30%)	19 (28%)	

Results are expressed as mean unless otherwise specified.

MML, modified Misgav-Ladach technique; PK, Pfannenstiel and Kerr technique; NS, nonsignificant.

Table II. Main indications for cesarean delivery

	MML (<i>n</i> = 77) (%)	PK (<i>n</i> = 69) (%)	<i>p</i> -value
Unreassuring fetal state	19 (25)	19 (27)	NS
Labor dystocia	17 (22)	15 (22)	NS
Breech presentation	10 (13)	6 (9)	NS
Suspected fetal-pelvic disproportion	8 (10)	8 (12)	NS
Maternal and fetal disorders contra-indicating vaginal delivery*	12 (16)	10 (14)	NS
Other	11 (14)	11 (16)	NS

*Maternal – HIV infection, orthopedic conditions, ophthalmologic disease. Fetal malformations incompatible with vaginal delivery.

MML, modified Misgav-Ladach technique; PK, Pfannenstiel and Kerr technique; NS, nonsignificant.

the two-layer closure (7). There is still some controversy regarding its impact on the next pregnancy, with some studies showing a similar rate of uterine dehiscence (6,9,22) and one study showing a higher rate than the two-layer closure (23). Some evidence reports that thickness of the scar, as evaluated by postoperative ultrasound, is reduced in the one-layer suture technique (24), but whether this impacts on future pregnancies remains undetermined. Non-closure of the peritoneum reduces operative time and has been shown not to affect postoperative morbidity, maternal pain, bowel function restoration, or adhesion formation (11–16,25). There is some evidence that it is associated with fewer postoperative complications and is more cost-effective than closing both peritoneal layers (17). The combination of the Joel-Cohen abdominal opening technique, one-layer suturing of the uterus, and non-closure of the peritoneum (Misgav-Ladach technique) has been associated with shorter operative time, quicker recovery, and lesser need for postoperative medications, when compared with traditional cesarean section (26–28). It has also been shown to be more cost-effective (26).

A further advantage of the technique may be the shorter time needed for child delivery (28).

As previously stated, patients' aesthetical preferences regarding the site of the scar and emerging evidence in favor of alternative individual steps in the procedure were the main reasons that led us to modify the Misgav-Ladach technique. A skin incision performed underneath the upper border of the pubic hairline was considered aesthetically more acceptable by the majority of our patients. Nevertheless, the remaining steps of the Joel-Cohen technique for opening the abdominal wall can usually be performed if the midline subcutaneous incision is directed upward, so as to reach the rectus sheath above the insertion of the pyramidalis muscles. We have also found that the lateral extension of the rectus sheath incision can usually be performed manually, even when previous cesarean scars are present. This gives a good control of the extension of the incision while still leaving clear borders for suturing at the end. Another small modification introduced in the technique was the avoidance of the lateral extension of the uterine peritoneum incision or

Table III. Peri- and postoperative results

	MML (<i>n</i> = 77)	PK (<i>n</i> = 69)	<i>p</i> -value
Operating time (min): median (range)	21 (14–47)	33 (23–57)	<0.001
Requested paracetamol (g): median (range)	3 (0–6)	3 (0–6)	1.0
Bowel restitution by second postoperative day			0.087
Yes	61 (79%)	46 (67%)	
No	16 (21%)	23 (33%)	
Febrile morbidity			0.151
No	76 (99%)	65 (94%)	
Yes	1 (1%)	4 (6%)	
Postoperative antibiotics			0.413
No	73 (95%)	64 (93%)	
Yes	4 (5%)	5 (7%)	
Endometritis	0	0	1.0
Wound complications at:			
Fourth postoperative day			0.634
Mild	3 (3%)	2 (3%)	
Severe	1 (1%)	0 (0%)	
Fifteenth postoperative day			0.634
Mild	3 (3%)	2 (3%)	
Severe	1 (1%)	0 (0%)	

MML, modified Misgav-Ladach technique; PK, Pfannenstiel and Kerr technique.

the dissection of the uterovesical space with fingers or swab. A 2–3-cm transverse midline scalpel incision through both peritoneum and uterine fibers with lateral digital extension involving both uterus and peritoneum has always provided adequate exposure for fetal extraction and subsequent uterine closure. Another procedure that is avoided is the routine manual removal of the placenta, which has been shown to increase the risk of maternal blood loss and postpartum endometritis (29). Consequently, it should not be performed before extensively trying out external uterine massage combined with light cord traction.

Although the issue was not addressed in this study, it is probable that many of the economical benefits associated with the MML technique, derived from the decreased operating time and reduction in suturing material, are applicable to the MML technique. This study shows that, when compared with the Pfannenstiel–Kerr technique, it has a shorter operating time (an average of 12 min less), without significantly affecting febrile morbidity, time to bowel restitution, or need for postoperative medications. Long-term effects of the MML technique remain to be evaluated.

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Address for correspondence:

Pedro Xavier
Departamento de Ginecologia e Obstetrícia
Faculdade de Medicina
Universidade do Porto
Alameda Prof. Hernâni Monteiro
4200-319 Porto
Portugal
e-mail: sisporto@med.up.pt

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